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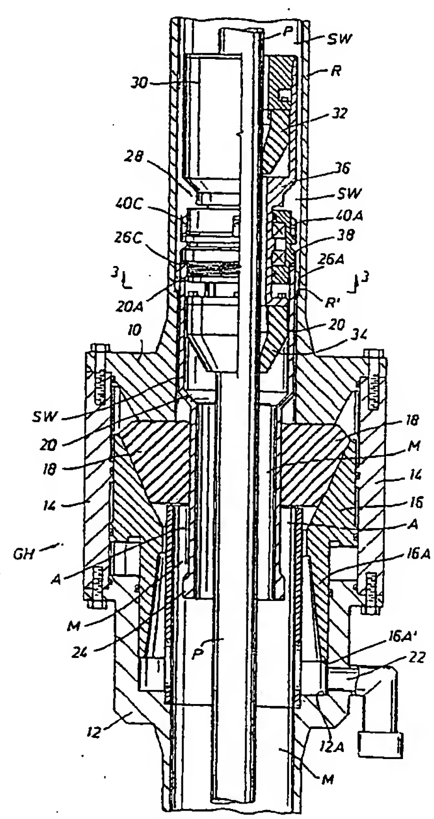
(54) Title: INTERNAL RISER ROTATING CONTROL HEAD

(57) Abstract

A system for providing a barrier between two different fluid densities in a riser while drilling in deep water. An internal housing (20) and a rotating control head (28) are positioned in a first housing (R) when a blowout preventer (GM) is in the sealed position. When the blowout preventer is in the sealed position about the internal housing, a pipe (P) can be rotated for drilling with the pressure of the fluid in the open borehole at one density (M) and the fluid above the seal at another density (SW). When the blowout preventer seal is in the open position, the threadedly connected bearing assembly and internal housing can be removed relatively quickly from the riser (R). Advantageously, a method for use of the system is also disclosed.



INTERNAL RISER ROTATING CONTROL HEAD

The present invention relates to a method and system for drilling in deep water. In particular, the present invention relates to a system for a quick release seal for sealing while drilling in deep water using a rotatable pipe and a method for use of the system.

Marine risers extending from a wellhead fixed on the floor of an ocean have been used to circulate drilling fluid back to a structure or rig. The riser must be large enough in internal diameter to accommodate the largest bit and pipe that will be used in drilling a borehole into the floor of the ocean. Conventional risers now have internal diameters of 19 ½ inches (50 cm), though other diameters can be used.

An example of a marine riser and some of the associated drilling components, such as shown in Figure 1, is proposed in U.S. Patent No. 4,626,135, assigned on its face to the Hydril Company, which is incorporated herein by reference for all purposes. Since the riser R is fixedly connected between a floating structure or rig S and the wellhead W, as proposed in the US 4,626,135, a conventional slip or telescopic joint SJ, comprising an outer barrel OB and an inner barrel IB with a pressure seal therebetween, is used to compensate for the relative vertical movement or heave between the floating rig and the fixed riser. A Diverter has been connected between the top inner barrel IB of the slip joint SJ and the floating structure or rig S to control gas accumulations in the subsea riser R or low pressure formation gas from venting to the rig floor F. A ball joint BJ between the diverter D and the riser R compensates for other relative movement (horizontal and rotational) or pitch and roll of the floating structure S and the fixed riser R.

The diverter D can use a rigid diverter line DL extending radially outwardly from the side of the diverter housing to communicate drilling fluid or mud from the riser R to a choke manifold CM, shale shaker SS or other drilling fluid receiving device. Above the diverter D is the rigid flowline RF, shown in Figure 1, configured to communicate with the mud pit MP. If the drilling fluid is open to atmospheric pressure at the bell-nipple in the rig floor F, the desired drilling fluid receiving device must be

limited by an equal height or level on the structure S or, if desired, pumped by a pump to a higher level. While the shale shaker SS and mud pits MP are shown schematically in Figure 1, if a bell-nipple were at the rig floor F level and the mud return system was under minimal operating pressure, these fluid receiving devices may have to be located at a level below the rig floor F for proper operation. Since the choke manifold CM and separator MB are used when the well is circulated under pressure, they do not need to be below the bell nipple.

As also shown in Figure 1, a conventional flexible choke line CL has been configured to communicate with choke manifold CM. The drilling fluid then can flow from the choke manifold CM to a mud-gas buster or separator MB and a flare line (not shown). The drilling fluid can then be discharged to a shale shaker SS, and mud pits MP. In addition to a choke line CL and kill line KL, a booster line BL can be used.

In the past, when drilling in deep water with a marine riser, the riser has not been pressurized by mechanical devices during normal operations. The only pressure induced by the rig operator and contained by the riser is that generated by the density of the drilling mud held in the riser (hydrostatic pressure). During some operations, gas can unintentionally enter the riser from the wellbore. If this happens, the gas will move up the riser and expand. As the gas expands, it will displace mud, and the riser will "unload". This unloading process can be quite violent and can pose a significant fire risk when gas reaches the surface of the floating structure via the bell-nipple at the rig floor F. As discussed above, the riser diverter D, as shown in Figure 1, is intended to convey this mud and gas away from the rig floor F when activated. However, diverters are not used during normal drilling operations and are generally only activated when indications of gas in the riser are observed. US 4,626,135 has proposed a gas handler annular blowout preventer GH, such as shown in Figure 1, to be installed in the riser R below the riser slip joint SJ. Like the conventional diverter D, the gas handler annular blowout preventer GH is activated only when needed, but instead of simply providing a safe flow path for mud and gas away from the rig floor F, the gas handler annular blowout provider GH can be used to hold limited pressure on the riser R and control the riser unloading process. An auxiliary choke line ACL is used to circulate mud from the

riser R via the gas handler annular blowout provider GH to a choke manifold CM on the rig.

Recently, the advantages of using underbalanced drilling, particularly in mature geological deep water environments, have become known. Deep water is considered to be between 3,000 to 7,500 feet (900 to 2300 m) deep and ultra deep water is considered to be 7,500 to 10,000 feet (2300 to 3000 m) deep. Rotating control heads, such as disclosed in U.S. Patent No. 5,662,181, have provided a dependable seal between a rotating pipe and the riser while drilling operations are being conducted. PCT publication no. WO99/45228, entitled "Method and Apparatus for Drilling a Borehole Into A Subsea Abnormal Pore Pressure Environment" proposes the use of a rotating control head for overbalanced drilling of a borehole through subsea geological formations. That is, the fluid pressure inside the borehole is maintained equal to or greater than the pore pressure in the surrounding geological formations using a fluid that is of insufficient density to generate a borehole pressure greater than the surrounding geological formation's pore pressures without pressurization of the borehole fluid. U.S. Serial No. 09/260,642, filed March 2, 1999, proposes an underbalanced drilling concept of using a rotating control head to seal a marine riser while drilling in the floor of an ocean using a rotatable pipe from a floating structure. U.S. Patent No. 5,662,181 and Serial No. 09/260,642 and WO99/45228 are incorporated herein by reference for all purposes. Additionally, provisional application Serial No. 60/122,350, filed March 2, 1999, entitled "Concepts for the Application of Rotating Control Head Technology to Deep water Drilling Operations" is incorporated herein by reference for all purposes.

It has also been known in the past to use a dual density mud system to control formations exposed in the open borehole. See *Feasibility Study of a Dual Density Mud System For Deepwater Drilling Operations* by Clovis A. Lopes and Adam T. Bourgoyne, Jr., © 1997 Offshore Technology Conference. As a high density mud is circulated from the ocean floor back to the rig, gas is proposed in this paper to be injected into the mud column at or near the ocean floor to lower the mud density. However, hydrostatic control of abnormal formation pressure is proposed to be maintained by a weighted mud system that is not gas-cut below the seafloor. Such a dual density mud system is proposed to reduce drilling costs by reducing the number of

casing strings required to drill the well and by reducing the diameter requirements of the marine riser and subsea blowout preventers. This dual density mud system is similar to a mud nitrification system, where nitrogen is used to lower mud density, in that formation fluid is not necessarily produced during the drilling process.

U.S. Patent No. 4,813,495 proposes an alternative to the conventional drilling method and apparatus of Fig. 1 by using a subsea rotating control head in conjunction with a subsea pump that returns the drilling fluid to a drilling vessel. Since the drilling fluid is returned to the drilling vessel, a fluid with additives may economically be used for continuous drilling operations. Therefore, US 4,813,495 moves the base line for measuring pressure gradient from the sea surface to the mudline of the sea floor. This change in positioning of the base line removes the weight of the drilling fluid or hydrostatic pressure contained in a conventional riser from the formation. This objective is achieved by taking the fluid or mud returns at the mudline and pumping them to the surface rather than requiring the mud returns to be forced upward through the riser by the downward pressure of the mud column.

U.S. Patent No. 4,836,289 proposes a method and apparatus for performing wire line operations in a well comprising a wire line lubricator assembly, which includes a centrally-bored tubular mandrel. A lower tubular extension is attached to the mandrel for extension into an annular blowout preventer. The annular blowout preventer is stated to remain open at all times during wire line operations, except for the testing of the lubricator assembly or upon encountering excessive well pressures. The lower end of the lower tubular extension is provided with an enlarged centralizing portion, the external diameter of which is greater than the external diameter of the lower tubular extension, but less than the internal diameter of the bore of the bell nipple flange member. The wireline operation system of US 4,836,289 does not teach, suggest or provide any motivation for use a rotating control head, much less teach, suggest, or provide any motivation for sealing an annular blowout preventer with the lower tubular extension while drilling.

In cases where reasonable amounts of gas and small amounts of oil and water are produced while drilling underbalanced for a small portion of the well, it would be

desirable to use conventional rig equipment, as shown in Figure 1, in combination with a rotating control head, to control the pressure applied to the well while drilling. Therefore, a system and method for sealing either the riser or the sub-sea blowout preventer stack (BOPS) while drilling in deep water that would allow a quick rig-up and release using conventional pressure containment equipment would be desirable. In particular, a system that provides sealing of the riser at any predetermined location, or, alternatively, is capable of sealing the BOPS while rotating the pipe, where the seal could be relatively quickly installed when required, and quickly removed when it is no longer required, would be desirable.

According to a first aspect, the present invention provides apparatus for forming a borehole using a rotatable pipe and a fluid, comprising:

an upper tubular disposed above said borehole;

a bearing assembly having an inner member and an outer member and being positioned with said upper tubular, said inner member rotatable relative to said outer member and having a passage through which the rotatable pipe may extend;

a bearing assembly seal to sealably engage the pipe with said bearing assembly; and

a holding member for positioning said bearing assembly with said upper tubular.

Further preferred features are set out in claims 2 to 7.

According to a second aspect, the present invention provides a method of increasing the pressure of a fluid in a borehole while sealing a rotatable pipe, comprising the steps of:

positioning an upper tubular above the borehole;

holding a bearing assembly within said upper tubular, said bearing assembly having an inner member and an outer member wherein said inner member is rotatable relative to said outer member and having a passage through which the rotatable pipe may extend;

sealing said bearing assembly with said rotatable pipe; and

sealing said upper tubular with said bearing assembly to control the pressure of the fluid in the borehole.

Further preferred features are set out in claims 9 and 10.

Thus, preferred embodiments of the invention provide a system for drilling in deep water in the floor of an ocean using a rotatable pipe. The system uses an annular or ram blowout preventer to provide a seal, with or without a gas handler discharge outlet to convey pressurized mud returns from a riser to the rig while drilling. The blowout preventer is movable between a sealed position about an internal housing threadedly connected with a bearing assembly having a passage through which the rotatable pipe may extend to provide a barrier between two different fluid densities in the riser. The internal housing also includes a holding member or upset for blocking upward movement of the internal housing relative to the blowout preventer when the seal of the blowout preventer is in the sealed position. When the blowout preventer is in the sealed position about the internal housing and the pipe is rotated, the pressure of the fluid in the open borehole can be maintained at one density below the seal while another density fluid is maintained above the seal. When the blowout preventer seal is in the open position, the internal housing and the threadedly connected bearing assembly, can be removed relatively quickly from the riser.

Some preferred embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1 is an elevational view of a prior art floating rig mud return system, shown in broken view, with the lower portion illustrating the conventional subsea blowout preventer stack attached to a wellhead and the upper portion illustrating the conventional floating rig, where a riser having a conventional blowout preventer connected to the floating rig;

Figure 2 is an elevational view of a blowout preventer in a sealed position to position an internal housing and bearing assembly according to the present invention in the riser;

Figure 3 is a section view taken along line 3-3 of Figure 2;

Figure 4 is an enlarged elevational view of a blowout preventer stack positioned above a wellhead, similar to the lower portion of Figure 1, but with an internal housing and bearing assembly according to the present invention positioned in a blowout preventer communicating with the top of the blowout preventer stack and a rotatable pipe extending through the bearing assembly and internal housing according to the present invention and into an open borehole;

Figure 5 is a elevational view of an alternative embodiment of an internal housing according to the present invention;

Figure 6 is a preferred embodiment of a step down internal housing according to the present invention;

Figure 7 is an enlarged section view of a bearing assembly according to the present invention illustrating a typical lug on the outer member of the bearing assembly and a typical lug on the internal housing engaging a shoulder of the riser;

Figure 8 is an enlarged detail section view of an upset according to the present invention; and

Figure 9 is section view taken along line 9-9 of Figure 8.

Figures 2, 3 and 6 disclose preferred embodiments of an internal housing according to the present invention, and Figure 5 discloses an alternative embodiment of an internal housing according to the present invention.

Turning to Figure 2, the riser or upper tubular R is shown positioned above a gas handler annular blowout preventer, generally designated as GH. While a "HYDRIL" GH 21-2000 gas handler BOP or a "HYDRIL" GL series annular blowout handler could be used, ram type blowout preventers, such as Cameron U BOP, Cameron UII BOP or a Cameron T blowout preventer, available from Cooper Cameron Corporation of Houston, Texas, could be used. Cooper Cameron Corporation also provides a Cameron DL annular BOP. The gas handler annular blowout preventer GH includes an upper

head 10 and a lower body 12 with an outer body or first housing 14 therebetween. A piston 16 having a lower wall 16A moves relative to the first housing 14 between a sealed position, as shown in Figure 2, and an open position, where the piston moves downwardly until the end 16A' engages the shoulder 12A. In this open position, the annular packing unit or seal 18 is disengaged from the internal housing 20 of the present invention while the wall 16A blocks the gas handler discharge outlet 22. Preferably, the seal 18 has a height of 12 inches (30 cm). While annular and ram type blowout preventers, with or without a gas handler discharge outlet, are disclosed, any seal to retractably seal about an internal housing to seal between a first housing and the internal housing is contemplated as covered by the present invention. The best type of retractable seal, with or without a gas handler outlet, will depend on the project and the equipment used in that project.

The internal housing 20 includes a continuous radially outwardly extending upset or holding member 24 proximate to one end of the internal housing 20, as will be discussed below in detail. When the seal 18 is in the open position, it also provides clearance with the holding member 24. As best shown in Figures 8 and 9, the upset 24 is preferably fluted with a plurality of bores, like bore 24A, to reduce hydraulic pistoning of the internal housing 20. The other end of the internal housing 20 preferably includes inwardly facing right-hand Acme threads 20A. As best shown in Figures 2 and 3, the internal housing includes four equidistant spaced lugs 26A, 26B, 26C and 26D.

As best shown in Figures 2 and 7, the bearing assembly, generally designated 28, is similar to the Weatherford-Williams Model 7875 rotating control head, now available from Weatherford International, Inc. of Houston, Texas. Alternatively, Weatherford-Williams Models 7000, 7100, IP-1000, 7800, 8000/9000 and 9200 rotating control heads, now available from Weatherford International, Inc., could be used. Preferably, a rotating control head with two spaced apart seals is used to provide redundant sealing. The major components of the bearing assembly 28 are described in U.S. Patent No. 5,662,181, now owned by Weatherford U.S. Holdings, Inc. The US 5,662,181 is incorporated herein by reference for all purposes. Generally, the bearing assembly 28 includes a top rubber pot 30 that is sized to receive a top stripper rubber or

inner member seal 32. Preferably, a bottom stripper rubber or inner member seal 34 is connected with the top seal 32 by the inner member 36 of the bearing assembly 28. The outer member 38 of the bearing assembly 28 is rotatably connected with the inner member 26, as best shown in Figure 7, as will be discussed below in detail.

The outer member 38 includes four equidistant spaced lugs 40A, 40B, 40C and 40D. While a typical lug 40A is shown in Figures 2 and 7, and lug 40B is shown in Figure 2, lugs 40B and 40C are not illustrated. As best shown in Figure 7, the outer member 38 also includes outwardly-facing right-hand Acme threads 38A corresponding to the inwardly-facing right-hand Acme threads 20A of the internal housing 20 to provide a threaded connection between the bearing assembly 28 and the internal housing 20.

The two sets of lugs 40A, 40B, 40C and 40D on the bearing assembly 28, and the lugs 26A, 26B, 26C and 26D on the internal housing 20 serve three purposes. First, both sets of lugs serve as guide/wear shoes when lowering and retrieving the threadedly connected bearing assembly 28 and internal housing 20, both sets of lugs also serve as a tool backup for screwing the bearing assembly 28 and housing 20 on and off, lastly, as best shown in Figures 2 and 7, the lugs 26A, 26B, 26C and 26D on the internal housing 20 engage a shoulder R' on the upper tubular or riser R to block further downward movement of the internal housing 20, and, therefore, the bearing assembly 28, through the bore of the blowout preventer GH. The Model 7875 bearing assembly 28 preferably has a 8¾" (22.2 cm) internal diameter bore and will accept tool joints of up to 8½" (21.6 cm) to 8 5/8" (21.9 cm), and has an outer diameter of 17" (43 cm)to mitigate pistoning problems in a 19½" (50 cm) internal diameter marine riser R. The internal diameter below the shoulder R' is preferably 18¾" (22.2 cm). The outer diameter of lugs 40A, 40B, 40C and 40D and lugs 26A, 26B, 26C and 26D, are preferably sized at 19" (48 cm) to facilitate their function as guide/wear shoes when lowering and retrieving the bearing assembly 28 and the internal housing 20 in a 19½" (50 cm) internal diameter marine riser R.

Returning again to Figures 2 and 7, first, a rotatable pipe P can be received through the bearing assembly 28 so that both inner member seals 32 and 34 sealably

engage the bearing assembly 28 with the rotatable pipe P. Secondly, the annulus A between the first housing 14 and the riser R and the internal housing 20 is sealed using seal 18 of the annular blowout preventer GH. These above two sealings provide a desired barrier or seal in the riser R both when the pipe P is at rest or while rotating. In particular, as shown in Figure 2, seawater or a fluid of one density SW could be maintained above the seal 18 in the riser R, and mud M, pressurized or not, could be maintained below the seal 18.

Turning now to Figure 5, a cylindrical internal housing 20 could be used instead of the preferred step-down internal housing 20 having a step down reduced diameter 20C of 14" (36 cm), as best shown in Figures 2 and 6. Both of these internal housings could be at different lengths and sizes to accommodate different blowout preventers selected or available for use. Preferably, the blowout preventer GH, as shown in Figure 2, could be positioned in a predetermined elevation between the wellhead W and the rig floor F. In particular, it is contemplated that an optimized elevation of the blowout preventer could be calculated, so that the separation of the mud M, pressurized or not, from seawater or gas-cut mud SW would provide a desired initial hydrostatic pressure in the open borehole, such as the borehole B, shown in Figure 4. This initial pressure could then be adjusted by pressurizing or gas-cutting the mud M.

Turning now to Figure 4, the blowout preventer stack, generally designated BOPS, is in fluid communication with the choke line CL and the kill line KL connected between the desired ram blowout preventers RBP in the blowout preventer stack BOPS, as is known by those skilled in the art. In the embodiment shown in Figure 4, two annular blowout preventers BP are positioned above the blowout preventer stack BOPS between a lower tubular or wellhead W and the upper tubular or riser R. Similar to the embodiment shown in Figure 2, the threadly connected internal riser 20 and bearing assembly 28 are positioned inside the riser R by moving the annular seal 18 of the top annular blowout preventer BP to the sealed position. As shown in Figure 4, the annular blowout preventer BP does not include a gas handler discharge outlet 22, as shown in Figure 2. While an annular blowout preventer with a gas handler outlet could be used, fluids could be communicated without an outlet below the seal 18, to adjust the fluid pressure in the borehole B, by using either the choke line CL and/or the kill line KL.

Turning now to Figure 7, a detail view of the seals and bearings for the Model 7875 Weatherford-Williams rotating control head, now sold by Weatherford International, Inc., of Houston, Texas, is shown. The inner member or barrel 36 is rotatably connected to the outer member or barrel 38 and preferably includes 9000 series tapered radial bearings 42A and 42B positioned between a top packing box 44A and a bottom packing box 44B. Bearing load screws, similar to screws 46A and 46B, are used to fasten the top plate 48A and bottom plate 48B, respectively, to the outer barrel 38. Top packing box 44A includes packing seals 44A' and 44A'' and bottom packing box 44B includes packing seals 44B' and 44B" positioned adjacent respective wear sleeves 50A and 50B. A top retainer plate 52A and a bottom retainer plate 52B are provided between the respective bearing 42A and 42B and packing box 44A and 44B. Also, two thrust bearings 54 are provided between the radial bearings 42A and 42B.

As can now be seen, the internal housing 20 and bearing assembly 28 of the present invention provide a barrier in a first housing 14 while drilling that allows a quick rig up and release using a conventional upper tubular or riser R and blowout preventer. In particular, the barrier can be provided in the riser R while rotating pipe P, where the barrier can relatively quickly be installed or tripped relative to the riser R, so that the riser could be used with underbalanced drilling, a dual density system or any other drilling technique that requires pressure containment.

In particular, the threadedly assembled internal housing 20 and the bearing assembly 28 could be run down the riser R on a standard drill collar or stabilizer (not shown) until the lugs 26A, 26B, 26C and 26D of the assembled internal housing 20 and bearing assembly 28 are blocked from further movement upon engagement with the shoulder R' of riser R. The fixed preferably radially continuous upset or holding member 24 at the lower end of the internal housing 20 would be sized relative to the blowout preventer so that the upset 24 is positioned below the seal 18 of the blowout preventer. The annular or ram type blowout preventer, with or without a gas handler discharge outlet 22, would then be moved to the sealed position around the internal housing 20 so that a seal is provided in the annulus A between the internal housing 20

and the first housing 14 or riser R. As discussed above, in the sealed position the gas handler discharge outlet 22 would then be opened so that mud M below the seal 18 can be controlled while drilling with the rotatable pipe P sealed by the preferred internal seals 32 and 34 of the bearing assembly 28. As also discussed above, if a blowout preventer without a gas handler discharge outlet 22 were used, the choke line CL, kill line KL or both could be used to communicate fluid, with the desired pressure and density, below the seal 18 of the blowout preventer to control the mud pressure while drilling.

Because this system does not require any significant riser or blowout preventer modifications, normal rig operations would not have to be significantly interrupted to use the system. During normal drilling and tripping operations, the assembled internal housing 20 and bearing assembly 28 could remain installed and would only have to be pulled when large diameter drill string components were tripped in and out of the riser R. During short periods when the present invention had to be removed, for example, when picking up drill collars or a bit, the blowout preventer stack BOPS could be closed as a precaution with the diverter D and the gas handler blowout preventer GH as further backup in the event that gas entered the riser R.

As best shown in Figures 1, 2 and 4, if the gas handler discharge outlet 22 were connected to the rig S choke manifold CM, the mud returns could be routed through the existing rig choke manifold CM and gas handling system. The existing choke manifold CM or an auxiliary choke manifold (not shown) could be used to throttle mud returns and maintain the desired pressure in the riser below the seal 18 and, therefore, the borehole B.

As can now also be seen, the system along with a blowout preventer could be used to prevent a riser from venting mud or gas onto the rig floor F of the rig S. Therefore, the system, properly configured, provides a riser gas control function similar to a diverter D or gas handler blowout preventer GH, as shown in Figure 1, with the added advantage that the system could be activated and in use at all times – even while drilling.

Because of the deeper depths now being drilled offshore, some even in ultradeep water, tremendous volumes of gas are required to reduce the density of a heavy mud column in a large diameter marine riser R. Instead of injecting gas into the riser R, as described at the beginning of this specification, a blowout preventer can be positioned in a predetermined location in the riser to provide the desired initial column of mud, pressurized or not, for the open borehole B since the present invention now provides a barrier between the one fluid, such as seawater, above the seal 18 of the blowout preventer, and mud M, below the seal 18. Instead of injecting gas into the riser above the seal 18, gas is injected below the seal 18 via either the choke line CL or the kill line KL, so less gas is required to lower the density of the mud column in the other remaining line, used as a mud return line.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the details of the illustrated apparatus and construction and method of operation may be made without departing from the scope of the invention.

CLAIMS:

1. Apparatus for forming a borehole using a rotatable pipe and a fluid, comprising:

an upper tubular disposed above said borehole;

a bearing assembly having an inner member and an outer member and being positioned with said upper tubular, said inner member rotatable relative to said outer member and having a passage through which the rotatable pipe may extend;

a bearing assembly seal to sealably engage the pipe with said bearing assembly; and

a holding member for positioning said bearing assembly with said upper tubular.

2. Apparatus as claimed in claim 1, wherein said borehole has a borehole fluid pressure and said fluid has a pressure, comprising:

a first housing disposed between said borehole and said upper tubular, and

a seal disposed with said first housing whereby said first housing seal sealing said first housing with said bearing assembly.

3. Apparatus as claimed in claim 2, wherein said first housing includes an annular seal having a first opening and a second opening.

4. Apparatus as claimed in claim 2 or 3, comprising a subsea stack positioned with an ocean floor wherein said first housing is positioned above and in fluid communication with said subsea stack.

5. Apparatus as claimed in claim 2, 3 or 4, wherein said first housing seal is movable between a sealed position and an open position.

6. Apparatus as claimed in claim 2, 3, 4 or 5, wherein said first housing seal seals said first housing with said bearing assembly to allow said pipe to rotate while increasing the pressure of the fluid for controlling the borehole fluid pressure.

7. Apparatus as claimed in claim 2, 3, 4, 5 or 6, comprising an internal housing wherein said bearing assembly is removably positioned with said internal housing.

8. A method of increasing the pressure of a fluid in a borehole while sealing a rotatable pipe, comprising the steps of:

positioning an upper tubular above the borehole;

holding a bearing assembly within said upper tubular, said bearing assembly having an inner member and an outer member wherein said inner member is rotatable relative to said outer member and having a passage through which the rotatable pipe may extend;

sealing said bearing assembly with said rotatable pipe; and

sealing said upper tubular with said bearing assembly to control the pressure of the fluid in the borehole.

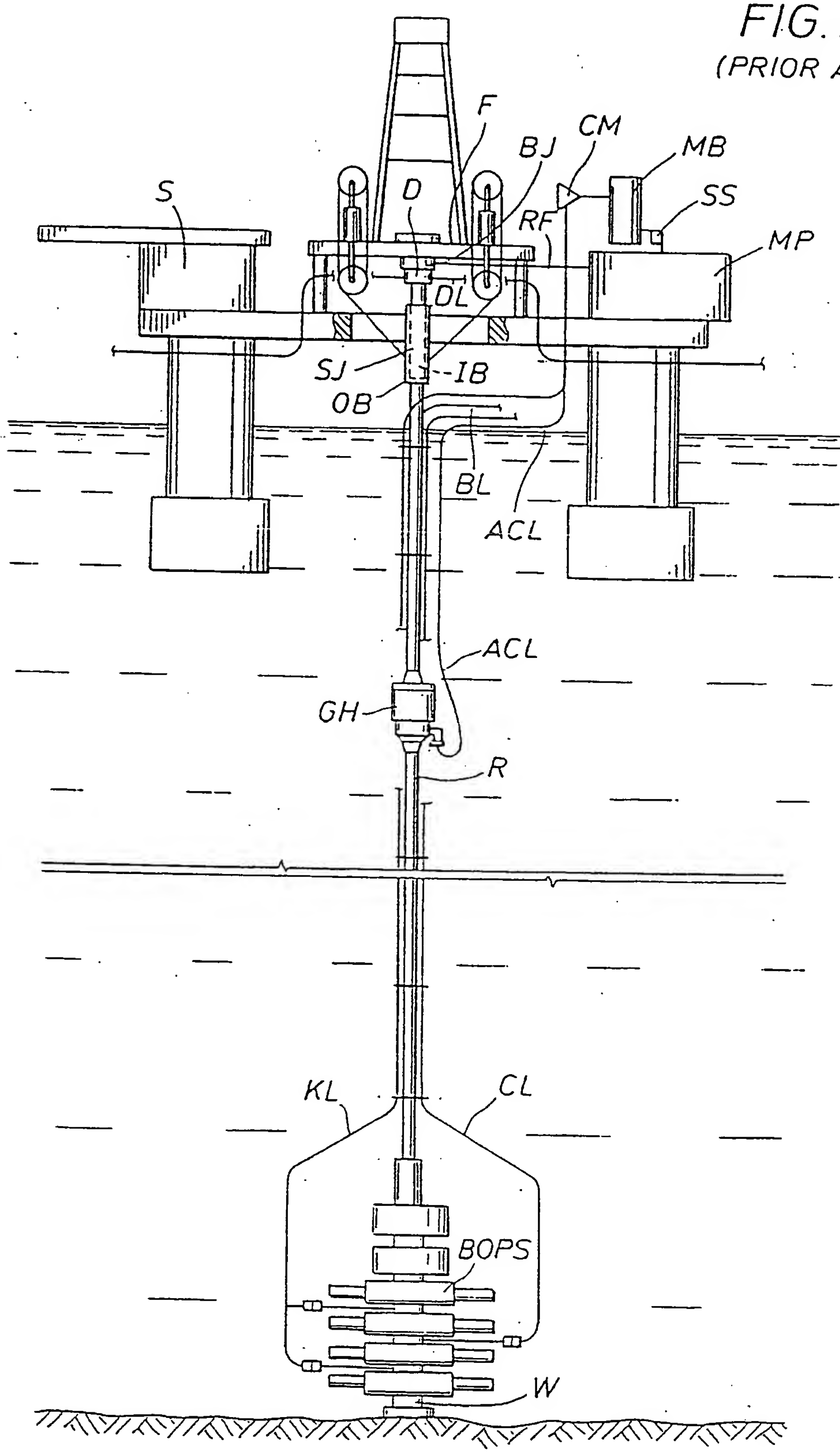
9. A method as claimed in claim 8, further comprising the step of:

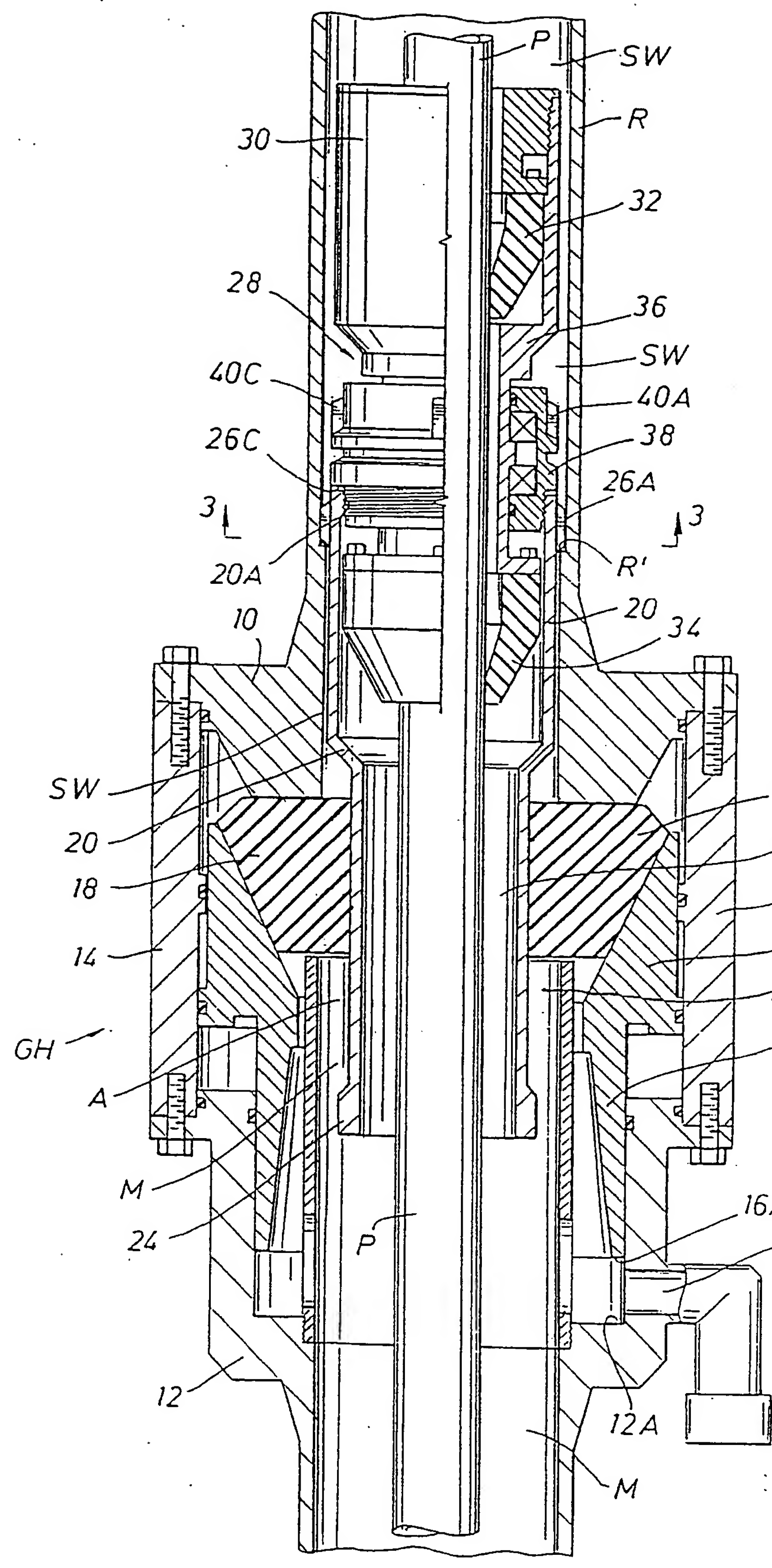
rotating the pipe while increasing the pressure of the fluid in the borehole.

10. A method as claimed in claim 8 or 9, further comprising the step of:

sealing said bearing assembly with an internal housing sized to be received within said upper tubular.

FIG. 1
(PRIOR ART)

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22
12
12A
M

FIG. 2

FIG. 3

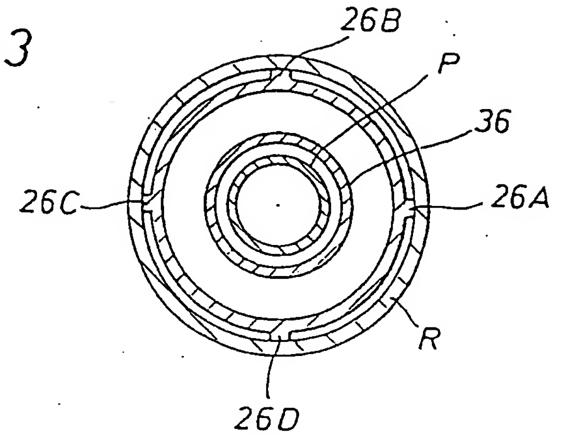


FIG. 5

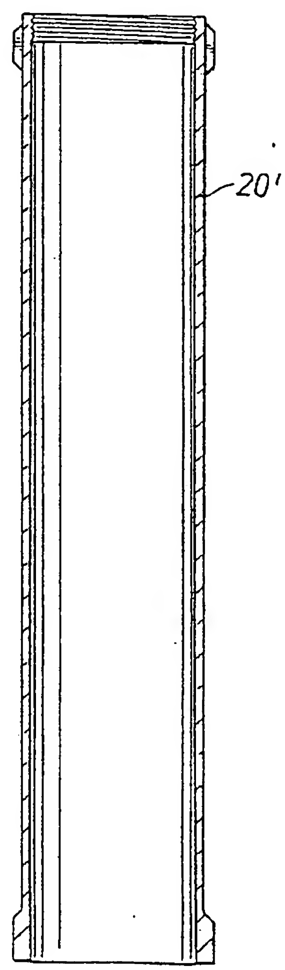
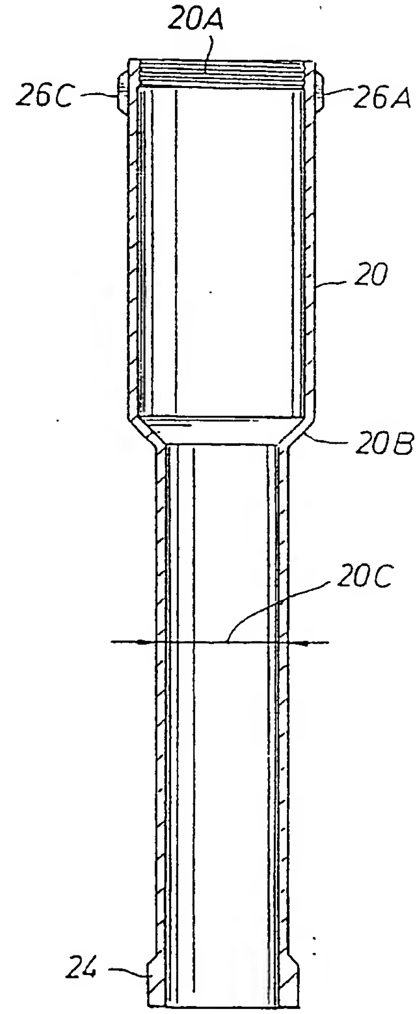


FIG. 6



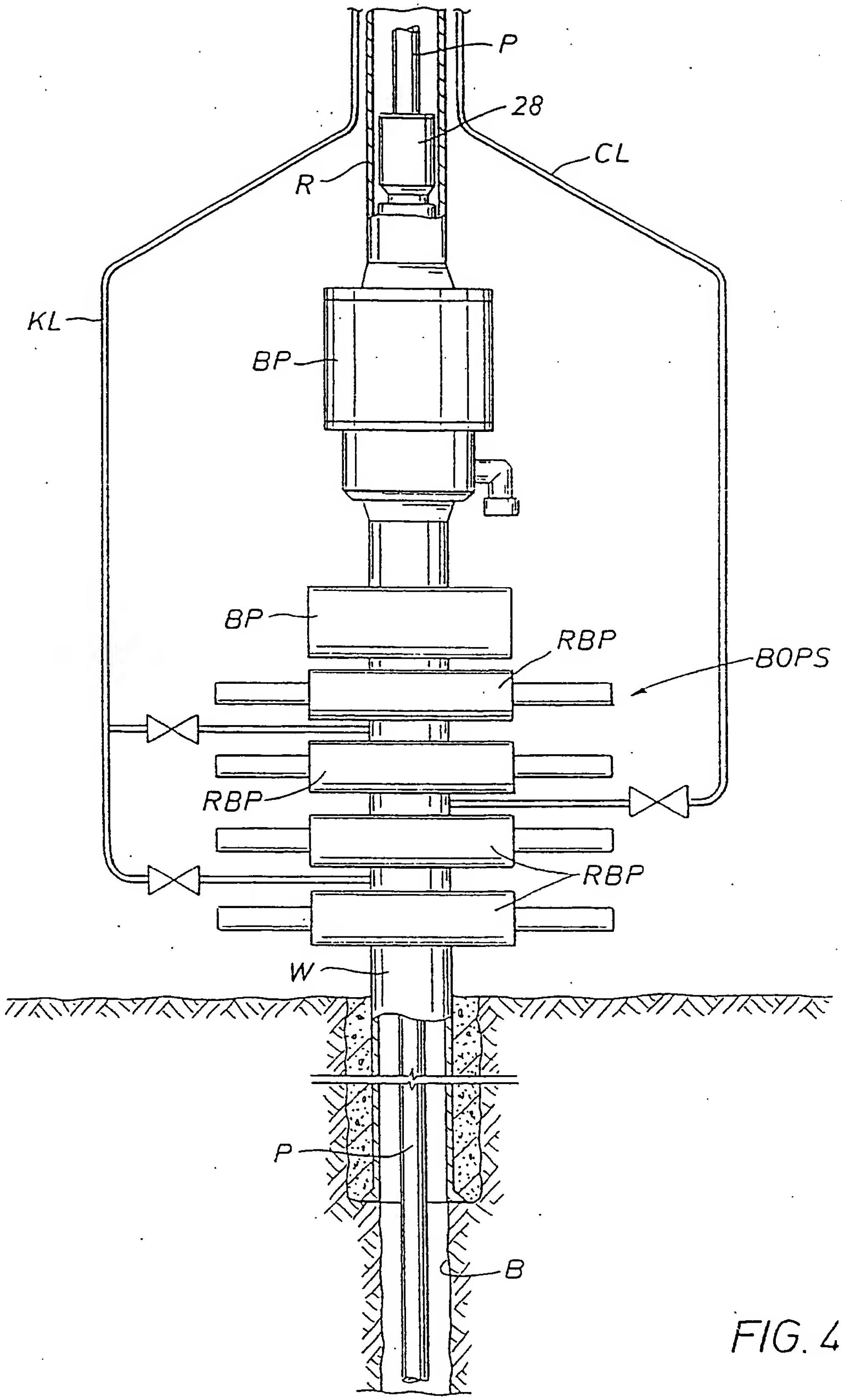


FIG. 4

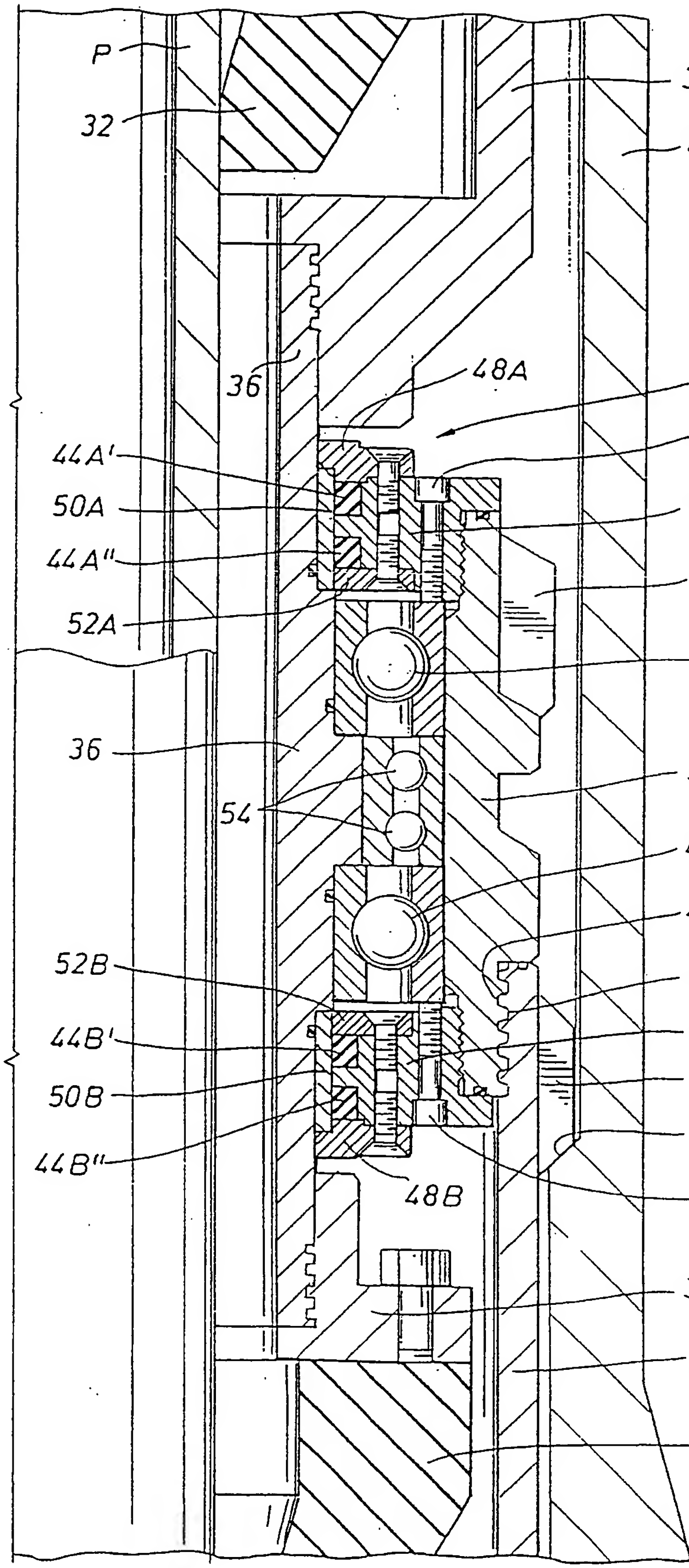
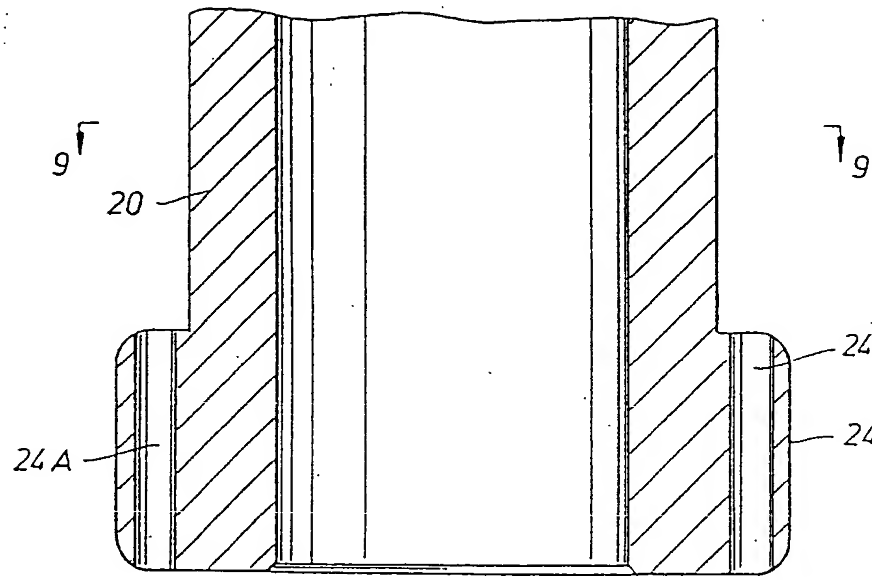

P
32
30
R
36
48A
28
46A
44A'
50A
44A
44A"
40A
52A
42A
36
38
54
42B
20A
52B
38A
44B'
44B
50B
26A
R'
44B"
48B
46B
36
20
34

FIG. 7

FIG. 8



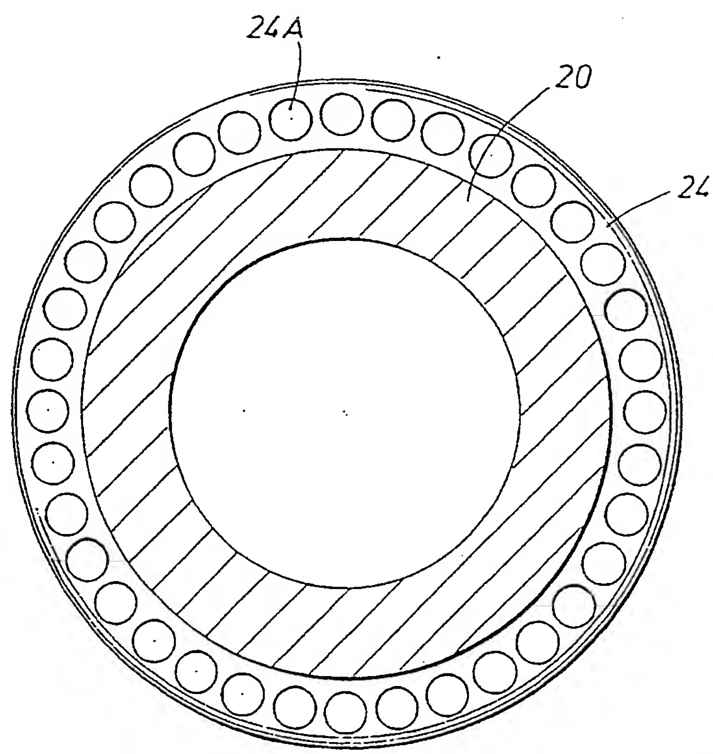
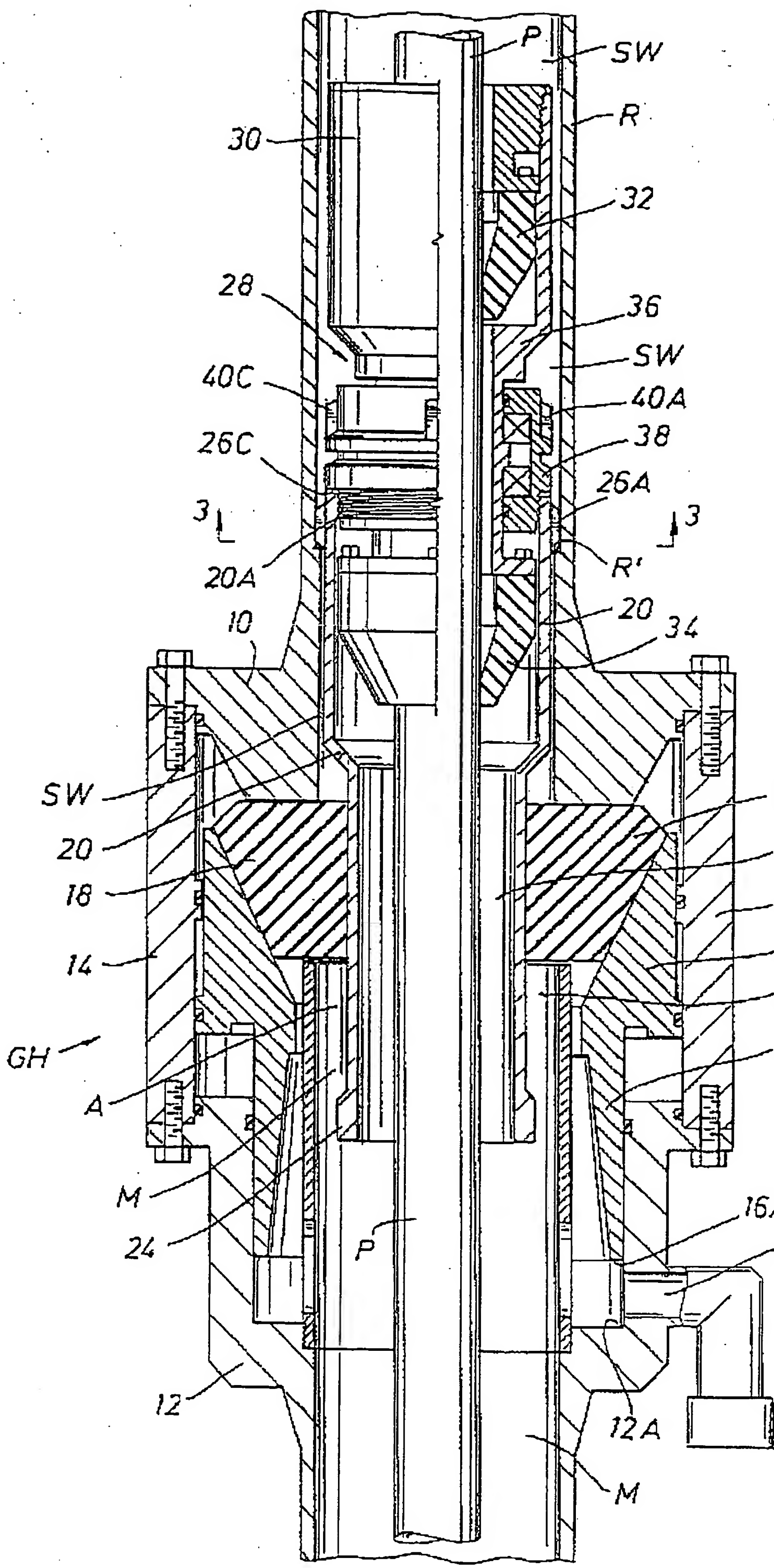


FIG. 9



P
SW
R
30
32
28
36
SW
40C
40A
38
26C
26A
3
3
20A
R'
20
34
10
SW
20
18
18
M
14
14
16
A
GH
A
16A
M
24
P
16A'
22
12
12A
M